FURTHER CONTRIBUTION RELATED TO IDENTIFICATION OF CONDITIONS FOR THE USE OF RIVER HOPPER BARGES AS AQUACULTURE FACILITIES

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DALJI PRILOG U RAZMATRANJU IDENTIFIKACIJE USLOVA ZA UPOTREBU REČNIH BARŽI KAO RIBNJAČKOG OBJEKTA

Abstrakt

U poslednjim godinama, zasnovano na međunarodnim iskustvima, iskazuje se potreba za uvođenje novih tehnologija u sektoru akvakulture u Srbiji. Pokrenut je projekat sa ciljem da se ukaže na mogućnost korišćenja rashodovanih rečnih barži kao objekata za akvakulturu. Predloženi vid intenzivnog gajenja konzumnog šarana, upotrebom rečnih šlepova kao protočnih sistema, predstavlja novinu u Srbiji. Budući da predstavlja nov pristup, a u svrhu određivanja adekvatne tehnologije, istraživanja su fokusirana na uticaj osnovnih faktora sredine koji utiču na rast šarana. Praćen je uticaj sadržaja kiseonika i temperature na rast šarana u konkretnim uslovima uzgojnog procesa. Tehničkim rešenjem priključenja vazdušnih kompresora na tanjiraste fino perforirane difuzore fiksirane na dnu barže, u potpunosti je rešen problem oksigenacije uzgojne vode. Temperatura je, pošto nije dostizala optimalne vrednosti za rast šarana, bila limitirajući faktor. Za 100 eksperimentalnih dana (67 dana sa ishranom), prosečna težina nasađenih riba bila je 1350.5 ± 269.47 g, postignuti individualni i ukupni prirast iznosili su 65.81% i 59.61% (mortalitet 4.22%), dok je konverzioni faktor hrane iznosio 1.52. Budući da je barža porinuta u rečni tok, kao i da se radi o protočnom sistemu, celokupni uzgojni proces je u velikoj zavisnosti od klimatskih uslova., što ukazuje na sezonsku primenu ovog tipa uzgoja za intenzivan uzgoj konzumne ribe, ili za intenzivan uzgoj mlađi za potrebe nasađivanja tokom najtoplijeg dela godine.

Ključne reči: *rečna barža, šaran, temperatura, kiseonik*

INTRODUCTION

In recent years, based on international experiences, there has been indication of a need for introducing new technologies into the aquaculture sector in Serbia (Marković *et al.* 2009). Flow-through system is defined as an aquaculture water system in which water continuously flows through the culture area and is discharged after a single pass (Styckney, 1979). To the best of our knowledge, in Serbia this type of systems are not practised for warmwater fish farming. The proposed type of intensive farming of warm-water fish species by using river hopper barges as flow-through aquculture facility is new to Serbia. This fact was impetus for studies with goals of identifying and determining conditions for the growth and survival of carp as well as developing production methods under specific rearing conditions. Being the new approach and in order to determine proper technology, studies were focused on investigations of basic environmental factors which influence carp growth and survival.

MATERIAL AND METHODS

The river hopper barge (59.9 x 6.65 m) used as aquaculture faciliti is located on the left bank of the Danube (km 1168 + 800, locality Krnjača). The rearing unit is 40 m long, 4 m wide and 2 m deep (total volume 350 m^3), and can be separated in individual compartments at every 1.5 m. One compartment was established ($V = 40\ m^3$, $P = 29.4\ m^2$), and directly to it continuous water supply from Danube was applied by using submersible pump (10 – 20 m^3/h). The two air compressors, each of 170 l/min capacity, were used for aeration.

Rearing compartment was stocked with 479.43 kg of carps (*Cyprinus carpio*) obtained from a commercial fish pond. In total 355 individuals of average weight of 1350.5 ± 269.47 g were stocked on July 28th 2010. At the time of stocking a sample of 100 fish was taken and they were measured (total lenght – TL, ± 1 mm; body mass – W, ± g). The accomodation of the fish to the experimental conditions was monitored for 5 days and during this period fish were not fed. Fish feeding started on August 2nd 2010., and fish were fed with SOPROFISH 38/12 feed type produced by Veterinaty Institute Subotica (granulation 8 mm; 38% proteins, 12% fats, 10% water, 4% cellulose, 10% ashes, vitamins: A 15 000 IU/kg, D_3 2 500 IU/kg, E 90 mg/kg, C 200 mg/kg). Daily amount of food was determined using feeding tables, depending on temperature conditions and the weight of fish stock. Ration size ranged from 4 to 9.5 kg, and one self-feeding device was used for feed supply. Feed was offered at 10:00 a. m., and on the following morning the amount of consumed feed was recorded. Fish were not fed on Sundays and days prior to control sampling. Two control samplings and total harvesting were performed on experimental days 42, 72 and 100, respectively. Sampled fish (n = 51 and n = 53) were anaesthesised (alchocol solution) and individual weight (± 1 g) and total lenght (± 1 mm) were measured; same procedure was applied for total harvesting. Mortality was observed daily. The feed conversion ratio (FCR) was calculated based on the consumed feed/weight gain ratio (died fish were not considered). Water temperature, pH and dissolved oxygen concentrations were measured daily while concentrations of ammonia, nitrites and nitrates were determined weekly.

RESULTS

Range of variations in the environmental parameters were 9.5 – 23.8 ºC, 4.01 – 10.11 mg/l, 7.39 – 8.77, 331.5 – 357 mS/cm, 0.48 – 1.11 mg/l, 0.039 – 0.047 mg/l and 0.23 – 0.574 mg/l for temperature, dissolved oxygen, pH, conductivity, nitrate concentration, nitrite concentracion and ammonia concentration, respectively. Recorded ranges of temperature and dissolved oxygen content indicate high variations of these parameters, which are of primary importance for fish growth. Remaining water quality parameters were within ranges that are acceptable for rearing warm water fish species.

In Table 1, results of rearing trial are summaraized. Rearing trial lasted 100 days, however, uptake of food was recorded on 67 days which had significant consequences on the final results. Respective to the initial values, final average weight showed an increase of 65.81%, while due to mortality (4.22%) weight gain amounted to 59.61% in total. On the other hand, feed conversion ratio was 1.52 representing satisfactory result.

Table 1. Growth, production, feed conversion and mortality of carp after 100 days of rearing trial.

Indicator	**Stocking**	**Harvest**
N	355	340
Stocking density (ind./m^3)	8.88	8.55
Stocking density (kg/m^3)	11.99	19.13
Stocking density (ind./m^2)	12.07	11.56
Stocking density (kg/m^3)	16.31	26.02
W ± SD (g)	1350.5 ± 269.47	2239.25 ± 515.44
B (kg)	479.43	765.22
No. of experimental days		100
No. of feeding days		67
Weight gain (kg)		285.8
Consumed feed (kg)		434.2
FCR		1.52
M (n)		15
M (%)		4.22

Growth of reared fish and dissolved oxygen conditions for the entire experimental period are presented in Figure 1. Throughout the experimental period dissolved oxygen concentrations varied, but generally, an increasing trend for this water quality parameter was observed. Overall average value was 6.46 ± 1.30 mg/l, while in respect to the experimental phases (control and final mesurments) average values were 5.74 ± 0.92 mg/l, 6.69 ± 1.28 mg/l and 7.65 ± 1.04 mg/l, for 1-42, 43-72 and 73-100 days period, respectively. Concentrations bellow 5 mg/l were recorded only in 9 occasions.

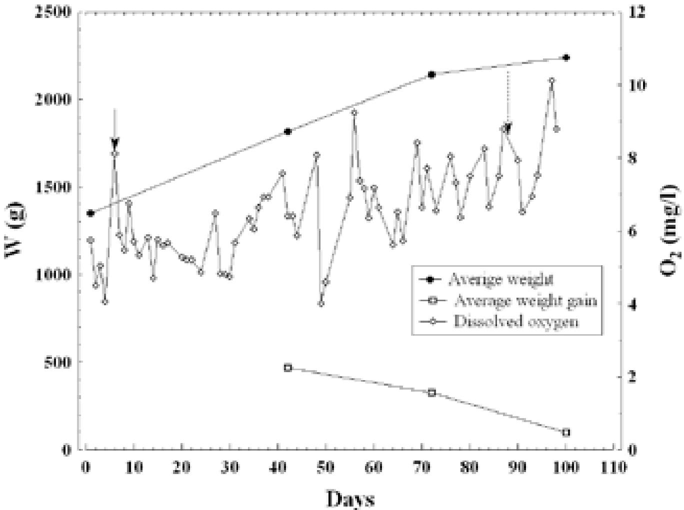

Figure 1. Growth of reared carp and variation of dissolved oxygen concentrations during the rearing period; solid arrow-start of feeding, dashed arrow-feeding cessation.

The relationship between growth of reared fish and temperature conditions for the entire experimental period is presented in Figure 2. Tempretarues above 20 ºC were recorded during 35 days from the beginning of experiment. On day 36 (1st September) temperature dropped by 1.6 ºC reaching 19.7 ºC, and from that point onwards a constant decrease of temperature was recorded. Overall average value was 18.29 ± 4.54 ºC, while in respect to the experimental phases (control and final mesurments) average values were 22.26 ± 1.49 ºC, 16.93 ± 1.45 ºC and 11.71 ± 1.36 ºC, for 1-42, 43-72 and 73-100 days period, respectively.

The increase in average weight and changes in weight gain were observed (Figs. 1, 2). Although positive growth has been obtained the slowing of growth rate was observed, particularly after 72 day of experiment, which is obviously the consequence of the temperature decrease.

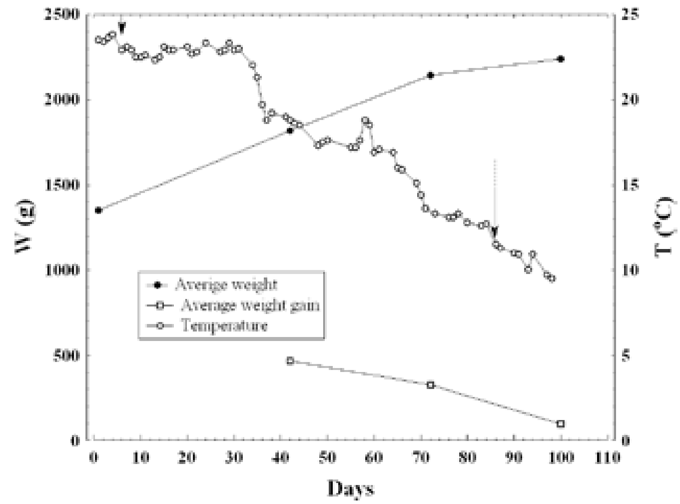

Figure 2. Carp growth and variation of temperature in the rearing water; solid arrow-start of feeding, dashed arrow-feeding cessation.

DISCUSSION

Temperature and dissolved oxygen content are among the most important factors affecting fish growth. The dissolved oxygen content during most of the rearing was, with some fluctuations, within the range which is considered suitable for intensive carp farming (Mitrović-Tutundžić *et al.* 1997). Air compressors were attached to the plate-shaped finely perforated air difussors fixed at the bottom of barge and this technical improvement solved the problems with dissolved oxygen content observed in pervious experiment (Regner *et al.* 2010). Such technical solution allowed relatively low water exchange rate, thus minimasing power demands. Huet (1994) stated that in Europe the optimum temperatures for carp growth being around 25 to 28 ºC, while the carps grow moderately well between 20 and 13 ºC, feebly between 13 and 5 ºC and not at all bellow that. Although optimal temperatures were not reached, our results were in agreement with reported ranges. Food uptake was continuosly recorded, and feeding activity was entirely dependent on water temperature. Feeding activity gradually weakened with lowering of temperature and actually ceased around 11ºC (day 88). This temperature is much higher in respect to literature reports that carp cease to feed when temperature falls bellow 5 ºC (Huet, 1994). Unfavourable temperature conditions and reduced feeding activity were reasons that production results were lower than expected. However, feed conversion ratio was considerably lower in comparison with data concerning literature reports on carp fed pelleted feed of the similar composition (Lukowicz, 1982; Mikavica *et al.* 2007; Bogut *et al.* 2007).

Barge is placed in river course and being flow-through system it is impossible to control temperature thus meaning that complete production process depends on climatic conditions. This fact indicates that suggested type of fish farming is resonable to apply on seasonal bases for fatenning marketable size fish, or for production of fingerlings for stocking purposes.

CONCLUSIONS

Studies on the possibilities of using river hopper barge as aquaculture facility are still in preliminary phase. The results obtained indicate that proposed type of fish farming might be applied on seasonal basis.

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